NURSERY NOTES

Forest Resources Branch
Queen's Park, Toronto, Ontario
March 1984 No.105

EFFECT OF EXTENDED COLD STORAGE AFTER OVERWINTER FROZEN STORAGE OF WHITE PINE AND WHITE SPRUCE

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Introduction

In most Ontario nurseries a considerable amount of bare-root planting stock is overwintered in frozen (-3°C) storage. Frequently, nurseries are forced to adjust the refrigeration temperatures from frozen to cold (1°C or higher) in the spring to accommodate the storage of spring lifted stock. This procedure causes the overwintered stock to be exposed to higher temperatures for the remainder of the storage period until shipping.

The purpose of this trial was to determine how long white pine (Pinus strobus L.) and white spruce (Picea glauca (Moench) Voss) could be held in cold storage after thawing without a reduction in vigour as measured by survival and height growth after outplanting.

Procedure

On 17 November 1981 after an accumulation of 133°C degree hardening days, 4500 2+2 white spruce (site region 6200) and 9000 3+0 white pine (site region 7200) were lifted at St. Williams nursery and field packaged, 250 trees per bag, in 3-ply Kraft bags with a polyethylene insert. A handful of damp moss was added as a moisture retaining material to the top and bottom of each bag. No root pruning or water dipping was done to the stock prior to packaging. An additional 75 trees of each species were lifted for stock characterization in the laboratory.

On the day of lifting, two bags of white pine were placed into cold storage (2-4°C) at St. Williams nursery and remained there for the entire storage period (154 days) while the remaining 16 bags were placed into frozen (-3°C) storage and transferred at predetermined time intervals to cold storage (Table 1). All 18 bags of white spruce and the remaining 18 bags of white pine were transported to the storage facilities of the Midhurst Research Station where two bags of each species were placed into cold storage (1°C) while the rest were placed in frozen storage and transferred at predetermined time intervals to cold storage (Table 1).

On 20 April 1982 the white pine stored at St. Williams was planted in Charlotteville township at a .75 x .9 m spacing in a randomized complete block design with 9 blocks and 9 treatments. Planting was done on a sandy to sandy/loam site by operational district crews. The weather during the planting was cool and wet with light to heavy showers throughout the day. Competition was partially controlled by a light application of Simazine 80W applied immediately after planting.

The Midhurst-stored pine and spruce were planted at the Midhurst Research Station on 3-4 May 1982 and 10-11 May 1982 respectively at a 1.5 m spacing on a clay loam soil. The site had been summer fallowed prior to planting. Competition was controlled after planting by a combination of mechanical cultivation and spot spraying with Simazine 80W.

Field performance and seedling vigour were determined by an analysis of variance of second year height measurements and percent survival after arcsin transformation.

Results and Discussion

The 3+0 white pine stock was large (Reese and Sadreika 1979) for shipping stock and the 2+2 white spruce was robust with a large root volume and stem diameter (Table 2). All white pine stock appeared to be in good condition at time of planting except for the stock overwintered in cold storage for the entire winter. This stock had extensive mould throughout the bundles of trees, a strong smell, and performed poorly in the field in both planting locations. All the white spruce stock appeared in good condition.

The white spruce stored very well over winter in both cold and frozen storage. Changing the storage temperature from frozen to cold had no effect on either growth or survival of the white spruce after outplanting (Table 1). The white pine stock stored poorly overwinter in cold storage and its survival was near zero. The poor storability was probably due to the large quantities of mould that occurred in the bags. Mould is more prevalent in cold than frozen storage (Nyland 1974). However, it has been shown that in the absence of mould, white pine can store well in cold storage (Mullin and Laupert 1981, Racey and Hutchison 1983).

The length of the holding period after thawing had an effect on field performance of white pine. Reduced survival and growth of the St. Williams stored stock occurred after 28 days of cold storage while reduced survival of the Midhurst planted stock occurred after 46 days of cold storage. The difference in treatment effect between St. Williams and Midhurst is attributed to different storage temperatures which were more closely regulated at Midhurst ($1^{0}C$) than at St. Williams ($2\text{-}4^{0}C$). The temperature at St. Williams was as high as it was to accommodate the cold storage of hardwood nursery stock. This demonstrates once again that different species have different storage requirements.

The major reason for the difference in white pine survival between St. Williams and Midhurst is due to an outbreak of northern pine weevil (Pissodes approximatus Hopk.) at Midhurst which killed approximately 15 percent of the trees in the first year after outplanting. However, we feel that the relative treatment effects within the plantation have not been compromised.

Conclusions

The effect of the cold storage treatment is partially confounded with the length of time in frozen storage which influences these findings somewhat.

The results suggest that white pine can be cold stored successfully for 28 days after overwinter frozen storage and that white spruce can be cold stored even longer than white pine after frozen storage. It is recommended that cold storage temperatures of about $1^{o}C$ be used whenever possible and temperature fluctuation is kept to a minimum. Cold storage for the entire winter is not recommended mainly because of the possibility of mould. Field staff should be made aware of storage duration so that field storage does not extend the total storage period beyond 28 days.

The higher the storage temperature in the field or nursery facilities, the shorter will be the period that stock may be successfully stored.

References

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Reese, K.H. and V. Sadreika. 1979. Description of bare-root shipping stock and cull stock. Ont. Min. Natur. Resour. 36 p.

Table 1. Second year height and survival measurements of 3+0 white pine and 2+2 white spruce planted at St. Williams and Midhurst after a varying number of days in cold storage following frozen storage. The trees in T9 were cold stored for the entire winter.

	Midhurst white pine			Midhurst white spruce			St. Williams white pine		
Treatment Code	number of days in cold storage	ht. (cm)	sur-vival %	number of days in cold storage	ht. (cm)	sur-vival %	number of days in cold storage	ht. (cm)	sur-vival %
T1	4	37	64.6a	11	42	98.9	7	43ab	97.0a
T2	11	39	67.3a	18	43	99.1	13	43ab	92.9ab
T3	18	38	69.6a	25	41	98.4	13	46a	94.2ab
T4	25	39	73.8a	32	43	98.4	28	46a	96.5a
T5	32	40	52.0a	39	43	98.2	35	41b	71.9c
T6	39	41	72.4a	46	42	98.2	42	42b	75.2c
T7	46	42	65.6a	53	42	98.4	49	41b	55.3cd
T8	53	38	43.8b	60	42	96.0	56	45a	42.4d
T9	167	ND	2.8c	174	41	98.4	154	ND	0.2e
		NS	***		NS	NS		*	***

* significant at 5% level

*** significant at .1% level

ND not sufficient data to include in analysis

NS not statistically significant

Numbers not followed by the same letter are significantly different at 5% level

Table 2. Stock characterization measurements of 3+0 white pine and 2+2 white spruce lifted at St. Williams nursery in the fall of 1981. (n = 75)

Species	Top length cm	Stem diameter cm	Top volume g	Root volume g	Top oven-dry weight g	Root oven-dry weight g
White pine	25.4±1.3[a]	.586±.030	24.4±2.5	3.2±2.3	7.44±2.01	3.07±0.42
White spruce	28.6±1.4	.784±.036	26.1±2.8	15.9±1.7	10.93±1.16	5.26±0.58

[a] 95% confidence interval about sample means.